

ROYAL METEOROLOGICAL SOCIETY: AUSTRALIAN BRANCH MEETING

Chairman's Address: 8 November 1979

The Morning Glory off the Gulf of Carpentaria Coast

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To demonstrate what the 'glory' is, the chairman showed time-lapse movies (speeded up 36 times) of the arrival of the glory from the northeast at Burketown at 9.30 am on 4 October 1979. It was remarkable for the rolling motion, very apparent in at least the first two of the five long cloud lines observed on that day. The wind speed at the ground reached about 7 m/s under each cloud line, with lulls between; cloud base was about 500 m and tops above 1700 m.

The speaker enunciated his reasons for studying the glory: first, that it is there, and has defied explanation for 100 years or so; second, for the light which such a study could throw on similar events believed to precede or accompany cold fronts on occasion further south.

The history of studies and descriptions of the glory was then reviewed; from Harry Treloar's passage in *Weather on the Australian Station* (1944), through the speaker's own theoretical and observational study in 1971-2, to Bruce Neal and his co-worker's synoptic study in 1974-5; to the just-published papers of Doug Christie and his colleagues from the Australian National University on solitary waves, based on a microbarometer array at Tennant Creek; and finally to the expeditions organised and planned by himself in 1978 and latterly during the period 22 September to 6 October 1979 under the auspices of Monash and Melbourne universities, CSIRO, the Ian Potter Foundation and this Branch of the Royal Meteorological Society.

This expedition consisted of eight members under the leadership of Roger Smith and Derek Reid at Burketown, where they lived in the Albert Hotel and waited with aeroplane and balloons at the ready for a glory to appear; and the speaker and his wife Els, whose task was to set up and maintain a line of recording instruments along the only suitable cross-Peninsula road, namely the very rough one, over 400 km long, from Chillagoe to Kowanyama, for the purpose of providing information on the origin of the glory.

In all, only three glories appeared at Burketown during the period. (Four occurred in the following week.) The first, on 29 September, consisted of two lines moving from the northeast and was atypical in that it reversed the direction of the then prevailing west wind for only 20 minutes. The second, on 3 October, was 'dry' (no cloud) at Burketown, and could not be investigated, although there were cloud lines at Mornington Island. The third event was the spectacular one shown in the movies, and was probed with great success, with the aircraft and balloons.

Analysis of the wind data (11 balloons in about 1½ hours) showed clearly that with the propagation velocity observed over its preceding 350 km of travel (nearly 9 m/s from the northeast) the wind flowed through the system (apart from one or two small closed circulations at the first two cloud lines) from front to rear with quite violent wavelike disturbances. Vertical velocities approached 10 m/s near the leading (upward) and trailing (downward) edges of the cloud lines. Wind components normal to the front were of closely comparable magnitude vertically and horizontally.

Temperature and humidity data revealed conclusively that the air in the disturbance was drawn from that preceding it: air in the up-draughts (up to 1000 m altitude) had come from the lowest 200 to 300 m in the undisturbed state, and that in the downdraughts (down to about 500 m) had originated above about 1500 m. The vertically integrated temperature to the top of the sounding (about 1700 m) at 8.25 am ahead of the front was equal (within 0.05 degrees) to that at 10.00 am behind the front. This evidence demonstrates that the glory is *not* a density current in which denser fluid replaces less dense in the lower layers.

Evidence from the pressure observations and the density structure preceding the glory also shows clearly that it does not consist of gravity waves: there is no regular period, and the longer period fluctuations are inconsistent with the resonant frequency of the air mass. Nor is the evidence in favour of the notion of a moving hydraulic jump or bore, since the relative flow shows no sustained decrease in velocity or increase in depth behind the leading edge.

The evidence is in fact fully consistent with the glory being a group of solitary waves or 'solitons', non-linear dispersive waves occurring in a deep, stable fluid and theoretically explained by Benjamin in 1967. This is the conclusion reached by Doug Christie and his colleagues in their 1979 paper in the *Journal of Geophysical Research*, and it is confirmed by the expedition results.

On the question of the genesis of groups of solitary waves, which are fairly common in Australia's tropical northern atmosphere, there is not much evidence. The glory in particular, however, is relatively consistent in its diurnal occurrence, and should be traceable to diurnal processes, probably sea breezes on the Cape York Peninsula coast, although the effects of moist convective processes cannot be conclusively ruled out.

The chairman showed a modelled sea breeze at times from 1500 to 2400 hours, with conditions pertaining to the Peninsula and 5 m/s onshore ambient (easterly) winds on the east side, offshore on the west. The sea breeze from the east coast has spread across most of the Peninsula by midnight, and attained a maximum speed of 10 to 12 m/s, before impinging on the remnants of the west coast sea breeze, which remains fairly weak throughout. It was stated that the special instrument array across the Peninsula (5 operative recording anemometers and 2 barometers) fully supported these model results.

The chairman suggested that the genesis of the solitary waves that produce the glory is probably traceable to the effects on the nocturnal inversion of the sudden change in the east coast sea breeze as it impinges on the remains of the west coast one at about 10 pm to midnight, in the general vicinity of the Peninsula's west coast. This would account for the direction, speed, time of day, occurrence in weak wind conditions, and known climatology of the glory reasonably well, although it was emphasised that some difficult problems remain.

A recommendation for any future work of this nature was that an acoustic sounder capable of measuring wind in three dimensions up to 1 or 2 km, such as that developed by the RAAF Academy at the University of Melbourne, was highly desirable.

The speaker concluded with acknowledgments on behalf of himself and his colleagues Roger Smith and Derek Reid to the bodies that provided funding for the expedition; to the Monash students who participated; to volunteer Richard Hagger who was responsible for some of the movies; and especially to Roger Merridew, the aircraft pilot, who donated his time and charged very moderately for the use of his aircraft, which, incredibly, he flew at 30 m through a morning glory in the cause of science.

J.W.Z.

